GCOS SECRETARIAT

GUAN Station, Penrhyn Atoll, 91801

PROPOSAL

RECONSTRUCTION AND UPGRADING OF UPPER AIR FACILITY

PENRHYN ISLAND

METEOROLOGICAL SERVICE OF NEW ZEALAND LIMITED

29 August 2003

1 Introduction

This proposal provides for the reconstruction and upgrading of the Upper Air facility at Penrhyn Island, in the Northern Group of the Cook Islands. This Radar Upper Wind measurement facility was commissioned on 1 December 1978. Although the project was only for one year, its life was extended a number of times for a variety of purposes. Today, Penrhyn continues to exist and has become a valuable Global Upper Air Network (GUAN) station, some 24 years since it was intended to be disestablished.

Neighbouring upper air stations are Rarotonga (700 miles to the south), Papeete (700 miles to the south east), Pago Pago (700 miles to the southwest), Funafuti (1,000 miles to the west) and the Hawaiian Islands 1,500 miles to the north). There are no stations in the sector north through east until the Americas are reached - some 3,000 miles away at the closest point. It contributes valuable data from this remote part of the South Pacific for operational input to global models and for regional use. Through its longevity, it provides increasingly important information for climatological evaluation especially for climate change and variability applications. There is considerable climatological interest in temp information from this site and it has been prioritized as a key station by the AOPC. The Cook Islands Government is supportive of the reconstruction and upgrading of this facility but is unable to financially contribute to the project.

The temporary plant and facilities that were established in 1979 have been maintained, as funds permitted, and added to over the years but if the station is to continue and be upgraded to radiosonde then reconstruction must occur. A catalyst for initiating a refurbishment proposal some two years ago was the withdrawal of the National Oceanic and Atmospheric Administration (NOAA) as a contributor to the program as the obsolete radar could no longer be supported. All remaining radar spares held by NOAA were supplied at the time of its withdrawal. Some critical spares that were supplied have now been used and the local technician has made innovative repairs to keep the radar operational. While every effort has been made to keep the radar operational, we must note that irrecoverable failure must soon occur and has been expected for some time. Following an explosion and fire in the vintage chemical hydrogen plant it was withdrawn from service on 28 February 2003. The station has been silent since then but is expected to resume from 1 November following the installation of a new hydrogen plant. This is contingent on the radar's serviceability after being inoperative since the hydrogen incident.

Discussions have been held over the past few years with different stakeholders and interest has been expressed in reconstructing the station and extending the Upper Air Program to temp and wind finding to high altitude using a Vaisala DigiCora system and RS80-15G/H radiosondes. The introduction of radiosonde would require greater lifting capacity of the weather balloons and consequently a modern hydrogen plant. As an electrolytic process is the most practical and cost-

effective option in this remote location, increased electrical capacity would be required. Modernization and refurbishment of the station buildings and facilities was identified as essential, together with consideration of how a rebuilt facility would be resourced.

An inspection visit to Penrhyn Island was made by a MetService engineer in October 2000 and information gathered on the present condition of the facilities. Options for a reconstruction were explored and a new site investigated.

Following the IPM of WMO VCP at Melbourne, Australia in February 2001, Mr. Dave Shaw and Dr Tokiyoshi Toya, both representing the principal remaining donors, met with Tony Veitch (Program Manager), Dr Neil Gordon, Garry Clarke and Steve Ready of MetService at Wellington, New Zealand to consider a proposal to upgrade and rebuild the station. The meeting concluded that the then capital costs were too much for any one donor. It was agreed that the station would continue in the immediate term with upper air consumables funded from the remaining donors following the NOAA withdrawal pending sourcing new funding streams or until an irrecoverable equipment failure. Until comparatively recently we had not been successful in locating new funding.

Three significant changes occurred since the meeting at Wellington resulting in some "high cost" items being donated or funded, and local utility services to the station improving. This has resulted in a reduction in re-development and operational costs, and now only leaves one item currently unfunded that is the subject of this Proposal. The changes are:

- The United Kingdom Meteorological Office (UKMO) has kindly supplied two surplus Digicora II systems but with some components faulty or incomplete. MetService has constructed one serviceable unit from them, which is now operational and ready for installation at Penrhyn.
- The UKMO has also kindly agreed to fund a new modern hydrogen plant, ancillary equipment and related work. This project is currently being implemented by MetService.
- There is now reticulated electricity to the radar station offering a more cost-effective solution that diesel generation. This is nominally for 18 hours each day. We have already connected to it but contrary to our hopes it has proven too unreliable to retire the diesel generators.

This document provides information on the Penrhyn Island facility, discusses the state of the station from information gathered at the 2000 inspection, and proposes the remaining reconstruction and upgrading work for donor consideration.

2 Background

2.1 Historical

To assist in achieving the objectives of World Weather Watch, a project to install and operate a wind finding radar station at Penrhyn Island, Cook Islands was approved on 23 August 1978. The project was carried out under the World Meteorological Organization's (WMO) Voluntary "Assistance Program". It was intended that the station would be operated under the WMO Global Weather Experiment project. This project lasted for one year after which it was intended that the station be closed and equipment withdrawn.

The participants in this project were:

- WMO
- The Government of the United States of America (through NOAA)
- The Government of New Zealand (through the former New Zealand Meteorological Service)

The United States of America contributed the plant and equipment – radar, spares, electricity generators, prefabricated buildings, refrigeration and other equipment, furnishings and facilities.

New Zealand managed the Cook Islands Meteorological Service at that time and contributed the salaries of the technician and provided installation resource.

The station was continued beyond the first year, essentially on a year by year basis with the parties contributing commensurately. In 1984 NOAA advised that it intended supporting the station through the first five years of TOGA until January 1990 with the intent of reviewing future involvement at that time. The Cook Islands Government endorsed this extension.

Approximately a year before the expiry of this extension the New Zealand Meteorological Service advised that it was unable to continue its support after January 1990. New Zealand subsequently agreed to extend funding until suitable funding alternatives could be put in place.

2.2 Present Funding Arrangements

The funding arrangements that existed until the NOAA withdrawal about two years ago had their origins in the 1990 agreements.

The essence of the 1990 agreements were:

- NOAA would continue to provide support for the radar and consumables provided other funding support was in place.
- The UKMO directed that surplus funds, held by MetService in the UKMO's WWW Trust Fund, could be used until alternative funding

became available. (This became a permanent UKMO support arrangement).

- The WMO program (now Voluntary Country Participation), under which the project was established, was reactivated to allow a continuation of support. We understand that funds were sourced from Japan's VCP contributions.
- New Zealand Meteorological Service agreed to provide program operational administration but not the technician's remuneration. (The New Zealand Meteorological Service was disestablished in June 1992 and became Meteorological Service of New Zealand Limited (MetService) – support has continued for day to day running and the resident technician is a contracted employee).

Until 1998 the Cook Islands provided hydrogen reagents. Following funding difficulties, these were subsequently funded with agreement from the other donors using surpluses from the then favorable exchange rates with no increase in the program budget.

In 2000, NOAA withdrew from the program providing its remaining spares for the radar and a final re-supply of balloons and radar targets. The UKMO and WMO VCP agreed to fund the upper air consumables after 2000. These costs were again contained within the existing budget using surpluses.

3 Station Description and Facilities

3.1 Overview

The station comprises a "handful" of small, prefabricated buildings and a radar on a robust radar tower one to two hundred metres from the end of the runway at Penrhyn Airport. The runway was constructed of compacted coral during World War II by the United States of America and used as a staging post for transiting aircraft in the Pacific theatre. The airport is some four kilometres from the village and the technician is the only person living at the airport.

The present technician has lived at Penrhyn for some 17 years and is married to a Penrhyn Islander. He has built a house at Rarotonga where his wife and younger children now live to provide their children the better education that is available there. His older children are at colleges in New Zealand.

In the first decade of the station's operation the living facilities were fully equipped (technicians completed six-month tours of duty in the early years). The present technician has been appointed for some 17 years and has purchased some of his own facilities. For example, bulk storage for fuel using a surplus local tank, a small 230-volt diesel electricity generator and appliances, and a truck. The station benefits to a degree from these personal contributions and logistically from not having to recruit new staff each six months.

3.2 Station Facilities

3.2.1 Fuel storage

The bulk tank is owned by the technician. This is filled from bulk supply on the ship using privately owned 200 litre transportable tanks. The technician has his own truck and fork lift. The fuel storage shelter is a lightweight timber frame, supporting even lighter weight corrugated aluminium roofing.

3.2.2 Generator shed

This is in reasonably sound condition. The problem areas are exterior wooded trim, window frames, and louvre frames. The fibrolite cladding is old and brittle, with nail heads pulling through. It may be possible to refix this with glue, but it is probable that any attempt to remove the sheets would result in them breaking up. The other option is to replace the cladding.

The ground between the fuel storage and the generator shed is heavily contaminated by spilled diesel / old engine oil.

3.2.3 Generators

There are two Onan generators; one is beyond economical repair, and one is new but with injector problems. These were manufactured at the time the station was installed, and parts, now that NOAA has withdrawn, are hard to get and expensive. The output is 110V, 60Hz, (as is required by the radar). The alternator windings have been rearranged to also provide 230 volts for air-conditioning, lighting, etc. A smaller Lister, owned by the technician, is used when the Onan is not required. By 2003, that was well-worn and requiring major repair work.

3.2.4 Radar tower

This is in very good condition and would be suitable for a Digicora antenna once the radar is retired.

3.2.5 Radar building

This building is in reasonable condition, however the roof needs replacing. The colour steel sheets have rusted from the cut ends, and have been extensively patched. The lighting is poor. The building would benefit from new fluorescent light fittings and larger windows (preferably double glazed). The air conditioner is serviceable and is about 18 months old.

3.2.6 Radar

This is an Enterprise Electronics Corporation WF100 “X” band radar. It is still in reasonable working order, which is a credit to the technician, but is well

past its normal replacement date. It is a prototype of the model used in New Zealand, so parts are not necessarily readily available. No spares are held for some of the critical sub assemblies, such as pulse package and scanner motor. (Both are different to the New Zealand ones). The final spares supplied by NOAA are well depleted – the last thyratron spare was used in February 2002. The "A" scope that is necessary for target acquisition has long failed as now has the technician's oscilloscope that was rigged as an alternative and that we are in the process of replacing. It is probable that the only reason that the radar is still functional is that the technician leaves it alone except for essential repairs and lubrication. Failure of a critical part, for which no spares are held, will mark the end of the present program.

3.2.7 Hydrogen / balloon filling shed

The exterior is in good condition, with the roof having been replaced recently. The chemical hydrogen plant was retired at the end of February 2003 following an incident, and a new electrolytic hydrogen plant will shortly be installed. This is modeled on our experience at our own stations. Three gas storage pressure vessels will be supplied that will not require inspection under current New Zealand regulations for ten years. After that time pressure vessels can be removed one at a time for testing with no disruption to the program. The Cook Islands, in general, models such regulations on New Zealand and has adopted the New Zealand standards.

As part of the installation we are upgrading the existing vintage station 286 PC and enabling our engineers to remotely fault diagnose as required.

We originally proposed that a Remote Balloon Launcher is installed and that the existing shed be used to house the hydrogen generator and the hydrogen gas storage pressure vessels. The cost of this equipment was higher than we anticipated and we have decided that as long as the technician, who is well experienced in handling hydrogen, is on station then we will continue with the existing facility. The new hydrogen plant will be located in a modified storage area adjacent to the balloon filling room. The Remote Balloon Launcher option should be re-visited if the present staffing arrangements change.

3.2.8 Run off pit

The hydrogen generator effluent, soak pit was small and obviously well drained. This may be due to the coral sub-strata. In 2000 there was very little disturbance to vegetation in the immediate area and it seemed that the residue was breaking down fairly quickly. The pit is now redundant and will be filled in.

3.2.9 Workshop

This is in reasonable condition, although there is some rust in the structural framing. The building is not air-conditioned, but uses a ceiling fan, which requires replacement. The lighting is poor and the window size much too small.

3.2.10 Storeroom

The roof is sound (aluminium), but the fibro-light walls have same problem as the generator shed. Fluorescent light fittings have been removed for installation in areas of higher lightning need. A set of double doors at one end needs replacing (or removal and walling up). The building was originally air-conditioned but the air conditioning has been removed. This will require air conditioning if radiosondes are stored.

3.2.11 Outside wash house /toilet

The exterior trim, including window surrounds need replacing, otherwise it is in reasonable condition.

3.2.12 Accommodation

The original side of the small two-room accommodation needs re-roofing. The extension side is satisfactory. The interior is clean and tidy, but requires refurbishment. New air conditioner units have recently been provided. The original, main appliances (refrigerator and the cooker) were replaced a long time ago by ones purchased by the technician. Some form of solar shielding (awnings, double-glazing, etc) would reduce the load on the air-conditioner. The lighting needs improving.

3.2.13 Plumbing

The water supply is rainwater, roof-collected, and stored in fibreglass tanks. The tanks have recently been painted, however, when one was moved, the bottom fell out due to the fibreglass delaminating. Reticulation (cold water only) is by pressure pump, which requires replacement. Hot water for the kitchen sink is from a Zip heater, which is more than 15 years old. This also must be replaced if the station is to continue. Sewerage is via a septic closet.

3.2.14 Communications

The communications facility that was originally established was HF Radio to the Cook Islands Meteorological Service at Rarotonga. Upper wind messages were copied at Rarotonga and sent on the Aeronautical Fixed Telecommunications Network (AFTN) facility that subsequently connected to the GTS.

The technician has established his communications system and messages are now sent by email with a direct interface at Rarotonga. Delays that were sometimes experienced in relaying through Rarotonga are now avoided and the link is directly with MetService's email gateway for direct input to the GTS. The HF radio is no longer used. An old 286 Personal Computer is used and is being replaced under the Hydrogen Plant Project.

3.2.15 Electrical wiring

As the station was supplied by NOAA, the electricity was originally all 110V. While 110V is still used for the radar and for some other purposes, much of the station has been rewired to 230V over the years. As further electrical work is being undertaken for the installation of the hydrogen plant, it is pragmatic and cost-effective to take that opportunity to finish off some remaining work and have the stations electrical system inspected by a registered Cook Islands electrician.

3.2.16 Boat and outboard motor

An aluminium open boat, about four metres in length, with an outboard motor was supplied for recreational purposes when the station was commissioned. Both items have worn out. The technician has purchased his own outboard motor. Neither should be replaced under any new construction. We see this as a cost to the technician.

3.2.17 Land - Present Station Site

The station is located at the airport but we understand that it is on a separate title. There have been some land lease issues relating to the airport but not to date with the station.

It is unclear whether the responsibility for the payment for the lease of the land rests with the Cook Islands or with the Project donors. Lease payments are not being made from the project funds and, we believe, are not being made from any Cook Islands Government source. The land lease records were destroyed in a fire at Rarotonga some years ago and it is difficult to trace historically.

The Cook Islands officials agreed some time ago to research the issue and resolve the matter. The Cook Islands Government officially recognizes the Penrhyn station as a "aid program" and as such all imports are exempt from any tax or import duty. Meetings with the Cook Islands Government to seek to finalize lease issues are planned.

4 Station Performance

We believe that the station performance is outstanding considering the state of the equipment. To illustrate this, the following is an extract from a recent report to donors.

"Operations During 2002/03

Upper Air

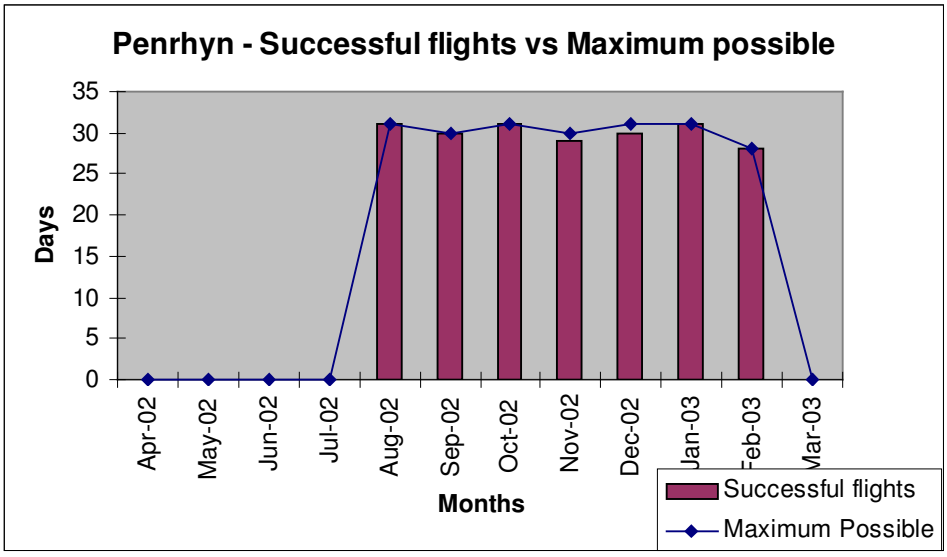
The upper air performance is exceptional in our view, and is a reflection on the dedication of the technician. Of note is that of all flights possible during this

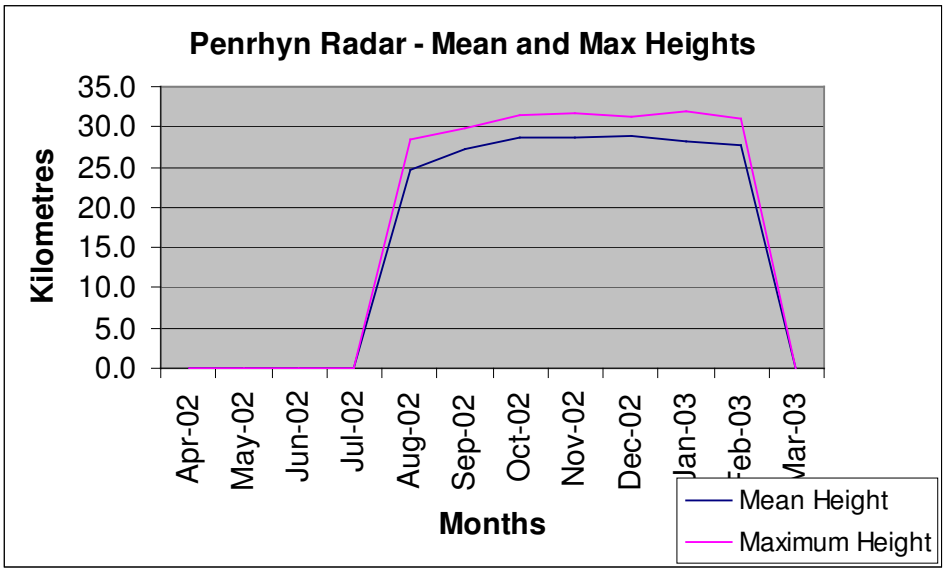
12 month period, only 2 were missed – one because the technician had to recover stores from the ship at flight time and the second when a second release was impractical due to heavy rain echoes. Excellent mean and termination heights were achieved, as is evidenced by the graphs.

Outages occurred from March until July when the hydrogen vessels were off station for their biennial mass and hydrostatic safety check, and again from March 2003 when the vintage hydrogen plant was retired following a fire and explosion resulting in injury to the technician.

It is again indicative of the dedication of the technician to the program that I was not informed of this incident until the end of the month less I suspended the program without a complete month's results. We were also lobbied by the technician to allow resumption on the grounds that he would accept responsibility for injury for any future incident. We could not determine the reason for the explosion and fire and I, as program manager, could not responsibly agree to any resumption."

Penrhyn Radar Station 91801





5 Staffing – Present and Future Options

5.1 Present

The present technician is well established, highly capable and has introduced benefits to the project over the years that he has personally funded. His personal initiatives have benefited the project but the downside is that it introduces some dependency and complicates any separation.

He received technical training through the then New Zealand Civil Aviation Department. The demands of Penrhyn, with obsolete equipment in a harsh environment, have resulted now in a technician that is immensely resourceful and able to diagnose and repair all of the plant and equipment at Penrhyn. The program operates effectively with much less attention than the other WWW stations we administer and achieves outstanding results. The serviceability of the fragile and obsolete radar is, without doubt, inseparably linked to the skills and knowledge of this technician.

With the intent to introduce radiosonde to Penrhyn, it is attractive to try to keep the radar operating as long as possible. This enables the cheaper RS80-15H (PTU) radiosonde to be used providing a saving over the more expensive RS80-15G (GPS) radiosonde of about USD75 per day. With the necessity of retaining the technician on station for the radar we believe the best option for now is to retain existing staffing arrangements. This should ensure that the high performance achieved to date continues thereby providing a good return on any station upgrading investment. However, we need to note that the continuation of the station does depend on the on-going support of the UKMO, WMO VCP and (for any radiosonde program) an on-going donor for this operational expenditure.

With the retention of a technician of this caliber and versatility, and who is "results driven", we suggest that the GCOS Secretariat may wish to keep in mind the technical capability at this remote equatorial location should it have any other monitoring requirement.

6 Proposal

6.1 General

We have been able to determine plant and equipment costs from suppliers, but costs associated with station reconstruction, installation, shipping and human resources are best estimates. The proposal provides for MetService to project manage, provide or arrange for technical resources and liaise with the Government of the Cook Islands. Included as part of this proposal is for the Digicora II system to be installed at Penrhyn and training provided to the technician.

Coupled with the UKMO funded activities, the outcome following the completion of this proposed work will be:

- The upper air station fully refurbished.
- A new hydrogen plant commissioned.
- An operational Digicora II system in place ready for the introduction of any radiosonde program, either supplementing or replacing the present radar operations.

Any on-going operational expenditure for upper air consumables has been excluded from this proposal but could be provided if wished.

The proposal is based on the following work.

6.2 Work to be completed

6.2.1 Station Buildings

- Generator Shed – Replace exterior cladding, exterior wooded trim, window frames and louvre frames.

- Radar Building – Replace roof, install windows and upgrade lighting.

- Hydrogen Building - Minor refurbishment as required.

- Workshop - Replace the present window with a larger window. Replace the ceiling fan and improve the lighting.

- Storeroom – Replace exterior cladding, remove double doors and clad over, repair lighting, install air conditioning.

- Outside wash house /toilet – Replace exterior trim, including window surrounds.

- House - Re-roof as required. Re-decorate the interior, provide solar shielding and upgrade the lighting.

- Plumbing – Replace plumbing as required and for new items.

6.2.2 New Plant and Equipment

- **Meteorological Equipment**

  - Radiosonde Ground Station – Construct mountings, install and commission the Vaisala Digicora II Ground Station plus ancillary equipment donated by the UKMO.

- Provide technical and operational training.

- **Electricity Generation on site**

  - Purchase and supply one Lister diesel generator to ensure continuity of electricity supply.

- **Water**

  - Water Tanks – Replace six of the existing water tanks.
  - Replace pressure pump
  - Replace water heater

- **Air conditioner**

  - Air conditioner – Purchase a new unit for the Storeroom

6.2.3 Installation / Removal / Refurbishment / Project Management Work

- Complete installation and commissioning of all Plant and Equipment including transportation from Wharf area
- Dispose of all surplus equipment either by write-off and environmentally acceptable disposal or by tendering process for any items with salvage value
- Undertake refurbishment as detailed.
- Restore soak pit area to a reasonable natural state.
- Freight all items

- Project management
  - Resource contractor
  - Source equipment
  - Liaise with Cook Islands Government as required to resolve land issues and formal project endorsements and approvals.
  - Facilitate export / import / through shipment at Rarotonga
  - Arrange radio licences (as needed)
  - Complete operational and technical training on new systems
  - Manage and administer the project

7 Pricing

7.1 Meteorological equipment

Digicora II Ground Station *Freight, mounting materials, excl installation*	**USD 900**

7.2 Non meteorological equipment

Station reconstruction and refurbishment *Includes, electrical re-wiring, lights upgrading additional air conditioner, water heater; re-cladding and re-roofing of buildings, solar shield, windows and trim repair / upgrade, redecorating and construction of racks for hydrogen tanks; PC; freight all items.*	**USD 23,600**
Lister Generator *Purchase and supply to Penrhyn*	**USD 10,500**

7.3 Human resource costs

Station reconstruction, refurbishment and upgrading *Includes, all technical sourcing, installation, commissioning and training; Station reconstruction - builder, Project management, interaction with Cook Islands Government, all related costs, travel expenses and per diems at standard UNDP rates.*	**USD 24,500**

7.4 Total Price

Total Price	**USD 59,500**